APPARATUS AND METHODS FOR FILLING CONTAINERS WITH PILLS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. Application No. 10/218,160, filed August 12, 2002, which is hereby incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

1) Field of the Invention

The present invention relates to packaging machines, and more particularly relates to automated packaging machines for filling containers with pills and associated methods.

2) Description of Related Art

Pharmaceutical medicines and associated packaging apparatus are typically subject to relatively strict consumer protection guidelines. For example, pills, capsules, and the like, must be produced and packaged in such a way as to at least meet the minimum sterility requirements mandated by federal regulations. In addition, the pills should be delivered into the packaging such that the contents accurately meet the claimed labeling "count", i.e., each package includes exactly the predetermined number of pills. Notwithstanding the above, it is also desired to package the product in a mass production operation to offset costs typically attributed to a labor intensive operation in order to provide an economic product.

In the past, pill filling machines have been proposed that provide automated bottle counts by filling a hopper with pills and causing a plurality of the pills to be caught by a pill capturing device, such as an array of rotary slats. The rotary slats drop the captured pills into a plurality of bottles disposed in alignment with the dropping pills. The bottles are distributed along an endless conveyor belt that is timed to advance and stop the bottles according to the filling operation.

Conventional pill capturing devices more particularly include a series of rotary slats each configured to receive, hold, and move a plurality of capsules or pills along a closed path. The rotary slats are typically discs fixed on a rotatable shaft and have a plurality of openings in the outer peripheral edge portion thereof for capturing individual pills. Accordingly, the closed path is arcuate and generally disposed between a pill hopper and discharge area above the conveyor belt. By the rotary action of the slat, the pills move in a direction normal to the conveyor belt. The pill capturing device then generally discharges the pills by rotating the slats, which move corresponding to the closed path, such that the pills fall out of the respective openings at the filling station. The pills are often funneled through a chute that empties into a corresponding bottle.

The "count," or number of pills in the bottle, is determined by positioning the bottles in the pill dropping zone for a predetermined time. The duration of the filling operation for each bottle corresponds to the number of openings in each slat that the machine is capable of delivering to the bottles per unit of time. The duration of the filling operation, speed of the rotary slats, and configuration of the pill capturing device are used to calculate the count.

Unfortunately, if the pill capturing device fails to capture a pill in each and every cavity or receptacle, or if a pill should mistakenly be diverted, at least one of the bottles can be improperly filled. The conventional solution to this problem is to situate an operator adjacent to the slats to ensure that each receptacle is filled with a pill. If a pill is missing, the operator manually places a pill in the receptacle. Such an approach involves labor costs and can be unsatisfactory for sterility purposes. In addition, the accuracy of the count of each bottle is largely determined by the operator and, as such, a fully and consistently accurate count cannot be guaranteed.

U.S. Pat. No. 6,185,901 to Aylward, which is incorporated herein by reference, provides an exemplary solution to this problem by way of a machine with independently driven rotary slats. The pills are allowed to fall into an exterior receptacle of a rotary slat and, in one embodiment, passed under a rotary brush in an attempt to prevent two pills from being disposed in the same receptacle. A separate counting device is associated with each rotary slat for counting each pill as it falls from the slat into the container. A positive count is provided for each container and improperly filled slats will not affect the

total count for that container. If a particular container has a low count, the respective slat can be further rotated to fill the container. Because the slats are independently driven, the other slats can remain stationary to prevent overfilling. Thus, the machine permits an accurate filling of each bottle.

One alternative apparatus is a rotatable drum, as provided in U.S. Pat. No. 4,094,439 to List. The rotatable drum includes a plurality of parallel rows of throughgoing holes that constitute receptacles for dragees. The dragees enter the receptacles in the drum from the interior of the drum at an inner input location, exit to the exterior of the drum at an outer retrieval location, and are filled into bottles. An ordering device facilitates the entry of the dragees into the receptacles, and feeler blades engage the receptacles. If any of the receptacles in an axially extending row do not contain a dragee, one of the feeler blades actuates a bolt pusher, which prevents any of the dragees in the row from being filled into the bottles. Instead, a solenoid and knockout bar empty the receptacles of the row. By preventing the bottles to be filled from partially filled rows of receptacles, the apparatus prevents the different bottles from being filled at different rates.

Undesirably, the additional mechanical components that are required for emptying the partially filled rows of apertures increase the complexity, cost, and likelihood of failure of the apparatus. Additionally, emptying the partially filled rows slows the process of filling the bottles because no pills are dispensed from those rows.

Accordingly, there is a great need for a packaging apparatus which provides an accurate count for each container and operates at a high speed. The apparatus should require a minimum of operator intervention. Additionally, the apparatus should be cost effective, both in initial cost and maintenance costs.

BRIEF SUMMARY OF THE INVENTION

The present invention provides an automated packaging apparatus for depositing a predetermined number of pills into a series of containers. The pills are first disposed into the interior of a plurality of rotary slats of the packaging apparatus. Each slat receives the pills into pill apertures at a peripheral edge portion of the slat, rotates, and dispenses the pills through the pill apertures. Each slat is rotated independent of the other slats, and a

detector and controller determine when the corresponding container has been filled. Thus, even if some pill apertures in some rotary slats do not receive or dispense pills, each rotary slat still provides an accurate count. In addition, by using a common interior space of a plurality of slats, no brush or other complex machinery is required.

The packaging apparatus includes a plurality of independently rotatable rotary slats. The rotary slats, which are formed of a polymer, are supported by a plurality of cradle rollers and positioned with small gaps between adjacent slats. Thus, the rotary slats are configured so that their outer peripheral edge portions define a common interior space. Each of the outer peripheral edge portions of the rotary slats defines an inner surface and a plurality of pill apertures. The pill apertures are configured to receive a pill from the common interior space at a first position and transmit the pill outside the rotary slats at a second position. In one embodiment, an inner contour of each of the rotary slats slopes toward the pill apertures to facilitate the entry of pills into the pill apertures. In another embodiment, the inner contour may also vary around the circumference of the rotary slat to facilitate the entry of pills into the pill apertures.

A shroud, which may be adjusted, extends from a location proximate to the first position to a location proximate to the second position such that the shroud prevents the pills from exiting the rotary slats through the pill apertures prior to the pills reaching the second position. A first air blower is located in the common interior space and configured to emit air towards the pill apertures at the second position. The pills may also be urged from the pill apertures by a plow that extends from within the rotary slats toward the pill apertures. The pills may fall from the pill apertures at the second position by virtue of the pill apertures being slanted downward toward the outside of the rotary slats when positioned at the second position.

A conveyor is configured to move open containers along a predetermined path of travel and position each of the containers adjacent a respective rotary slat to define a delivery path that extends between the second position and the container. Chutes define the delivery paths that extend from the second position of each rotary slat to the corresponding container. A delivery sensor detects the delivery of a pill through the delivery path. A second air blower is located outside of the rotary slats and is configured to emit air towards the pill apertures at a third position such that any jammed pills

positioned within the pill apertures at the third position are urged back into the common interior space. A sensor detects the quantity of the pills in the common interior space, and a reservoir gate controls the passage of pills from a reservoir, which holds the pills and feeds them into the common interior space.

Each of the rotary slats is independently rotatable, and a drive motor is in driving engagement with each of the rotary slats. Drive wheels, which are engaged with the rotary slats for independently rotating them, have outer surfaces that are contoured to match the outer peripheral edge portions of the rotary slats. A controller is connected to and controls the drive motors such that the rotary slats can be rotated for different durations. In one embodiment, the controller alternately accelerates and decelerates the rotary slats to vibrate them and agitate the pills.

Additionally, the present invention provides a method of depositing pills into containers. The pills are first disposed in a common interior space defined by a drum made up of several rotary slats. The pills are captured in pill apertures defined by the outer peripheral edge of the rotary slats. The rotary slats are accelerated and decelerated to agitate the pills and urge them into the pill apertures. Each of the rotary slats is independently rotated so that the pill apertures are moved to a position at which the pills are released from the apertures and delivered to containers. Air is directed toward the pills to facilitate their release from the apertures. If a pill fails to release from a pill aperture, air is directed toward the pill to urge the pill back into the interior of the drum. The released pills are directed toward chutes that delivery the pills toward the containers. As the pills are delivered, they are counted and the number of pills delivered to each container is calculated. When one of the containers receives a predetermined number of pills, the rotary slat corresponding to that container is stopped. The rotation of the other rotary slats is continued until each corresponding container has received the predetermined number of pills. The number of pills in the interior of the drum is also detected and additional pills are automatically fed into the interior as necessary.

Thus, the packaging apparatus of the present invention provides an accurate count for pills dispensed to each container. The apparatus requires a minimum of operator intervention, and it can operate at a high rate of speed. Additionally, the apparatus

provided is cost effective, both in initial cost and maintenance cost.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

Figure 1 is a perspective view of a packaging apparatus according to the present invention;

Figure 2 is an exploded view of the rotary slats of the drum of the packaging apparatus;

Figure 3 is an elevation view of the packaging apparatus according to the present invention shown with one chute partially cut away for illustrative clarity;

Figure 3A is a section view of the packaging apparatus of Figure 3 as seen from line 3A-3A;

Figure 3B is a section view of the packaging apparatus of Figure 3 as seen from line 3B-3B of Figure 3A;

Figure 4 is an elevation view of the rotary slat of the packaging apparatus of Figure 3;

Figure 4A is a section view of the rotary slat of Figure 4 as seen from line 4A-4A;

Figure 4B is a section view of the rotary slat of Figure 4 as seen from line 4B-4B;

Figure 4C is an enlarged section view of the pill apertures from the indicated section of Figure 4A;

Figure 5A is an elevation view of a plow with a rotary slat according to another embodiment of the present invention; and

Figure 5B is a section view of the plow and the rotary slat of Figure 5A as seen from line 5B-5B.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these

embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Generally described, the present invention is directed to an automated packaging apparatus **1**, which delivers pills **23** from a drum **2** into containers **22**. The term "pill" is used herein throughout, but the term is not intended to be limiting and includes any discrete articles of the type used in the pharmaceutical industry or otherwise including, but not limited to, capsules, caplets, gelcaps, dragees, and tablets. Similarly, the receiving container **22**, although illustrated as a bottle throughout, is not limited thereto and can be any one of a number of configurations which provides an opening for receiving discrete articles therein, such as pouches or boxes.

As shown in Figure 1, the packaging apparatus **1** includes a plurality of rotary slats **3** and end plates **13a**, **13b** which together comprise the drum **2**, a shroud **15** that surrounds part of the drum **2**, a drive assembly **41**, first and second cradle rollers **36**, **38**, a plurality of chutes **25** with delivery sensors **33**, and a conveyor **24**. The drive assembly **41** comprises a plurality of drive devices **42**, each of which includes a motor in driving engagement with a drive wheel **44**. As shown in Figure 3A, the packaging apparatus **1** also includes a level sensor **32** and first and second air blowers **20**, **21**. A filling station **26** is defined by a respective rotary slat **3**, chute **25**, delivery sensor **33**, and an aligned container **22**. As such, the apparatus includes a plurality of filling stations **26** corresponding to the number of rotary slats **3**.

As shown in Figures 2 and 3A, each rotary slat **3** defines an outer peripheral edge portion **4** and sidewalls **5**. The outer peripheral edge portion **4** of each rotary slat **3** defines a plurality of pill apertures **7** through which a pill **23** can pass. The sidewalls **5** define slat connection apertures **8** such that when the rotary slats **3** are positioned adjacent one another, the slat connection apertures **8** of adjacent rotary slats **3** correspond to one another and the rotary slats **3** together define a common interior space **12** of the drum **2**. In the figures, the first and second end plates **13a**, **13b** are positioned proximate to the first and last rotary slats **3a**, **3b**, respectively, so as to further define the common interior space **12**. The first end plate **13a** is a closed, circular plate. The second end plate **13b** defines a drum fill apparatus **14** through which pills **23** are fed into the drum **2**. In

another embodiment, the end plates **13a, 13b** are not separate components but are instead integral to the rotary slats **3** so that each of the first and last rotary slats **3a, 3b** of the packaging apparatus **1** define a slat connection aperture **8** in only one sidewall **5**. The opposite sidewall **5** of each of the first and last rotary slats **3a, 3b** comprises the end plates **13a, 13b** respectively and may define a drum fill aperture **14** or may be closed with no aperture.

A variety of materials can be used for the construction of the rotary slats **3** including, but not limited to, metals, metal alloys, and polymers. Preferably, the rotary slats **3** are formed of a durable, low friction material that is cost effective for manufacture. A preferred material is a compound comprising acrylonitrile-butadiene-sytrene and polytetrafluoroethylene. Depending on the type of pills **23** that are to be used with the rotary slats **3**, it may also be important that the material of the rotary slats **3** does not chemically affect the pills **23**. The other components of the packaging apparatus **1** can be made of the same or different materials. Another suitable material, which is preferable for the chutes **25**, is acetal or Delrin® polymer, available from DuPont.

The rotary slats **3** of the drum **2** are held between the cradle rollers **36, 38** and the drive wheels **44** of the drive assembly **41** with a small interslat gap **10** between adjacent rotary slats **3**. In one embodiment, each of the rotary slats **3** defines a double beveled alignment guide **11** on the outer peripheral edge portion **4** of the rotary slat **3**. The cradle rollers **36, 38** comprise cradle roller wheels **35** that define V-shaped slots **49** that correspond to the shape of the alignment guides **11** of the rotary slats **3**. Similarly, the drive wheels **44** of the drive assembly **41** also correspond to the shape of the alignment guides **11** of the rotary slats **3**. Thus, the engagement of the rotary slats **3** with the rollers **36, 38, 42** maintains the position of the rotary slats **3** and the interslat gaps **10** between the rotary slats **3**. The interslat gaps **10** are preferably smaller than the smallest dimension of the pills **23** so that the pills **23** cannot pass through the interslat gaps **10**. For example, the interslat gap **10** can be between about 0.5 and 1 millimeter. Further, each of the cradle roller wheels **35** and the drive wheels **44** are independently rotatable. Thus, each rotary slat **3** is rotatable separate from the other rotary slats **3**.

As shown in Figure 2, each of the rotary slats **3** and the end plates **13a, 13b** are individually removable from and assembleable on the cradle rollers **36, 38**. Preferably,

one or more of the cradle rollers **36**, **38** and the drive assembly **41** are at least partially removable to facilitate disassembly of the rotary slats **3**, which are secured between the cradle rollers **36**, **38** and the drive wheels **44** of the drive assembly **41**. For example, each of the drive devices **42** of the drive assembly **41** is supported by an air cylinder **51**. The air cylinders **51** hold the drive devices **42** against the rotary slats **3** so that the rotary slats **3** are held in alignment and so that the drive wheels **44** engage the rotary slats **3** without slipping. The force exerted by the air cylinders **51** can be adjusted to optimize the engagement of the drive wheels **44** with the rotary slats **3** during operation. Additionally, the air cylinders **51** can retract the drive devices **42** so that the rotary slats **3** can be removed or serviced. The assembly and disassembly flexibility provided by the invention is such that the packaging apparatus **1** can accommodate different numbers of filling stations **26** (such as the five illustrated in Figure 1) by increasing or decreasing the number of rotary slats **3**. Additionally, if one of the components malfunctions, the other filling stations **26** remain operable and, advantageously, modular repair or replacement of only the problematic rotary slat **3** or end plate **13a**, **13b** can improve repair costs and decrease machine downtime. Further, the rotary slats **3** can be replaced with other rotary slats **3** that are configured to dispense pills **23** with specific characteristics. Thus, by changing the rotary slats **3**, the packaging apparatus **1** can be used to dispense pills **23** of varying size, shape, weight, and composition.

Each rotary slat **3** is operably connected with the drive assembly **41** so that it can be operated individually, or separately from, the other rotary slats **3**. One possible drive assembly **41** is illustrated in Figure 3B. The drive assembly **41** includes the drive devices **42**, which are located at consecutively spaced positions that correspond to the positions of the rotary slats **3** so that each of the drive wheels **44** is rotatably connected to a respective rotary slat **3**. In the embodiment shown in Figure 3B, the drive wheels **44** are shaped to correspond to the alignment guides **11** of the rotary slats **3**. The alignment guides **11** keep the rotary slats **3** in proper alignment with the drive wheels **44** and separated from each other so as to maintain the interslat gaps **10**. The drive wheels **44** are formed of an elastomeric traction material such as hard rubber. Because each of the drive wheels **44** is rotatable independently of the other drive wheels **44**, each drive wheel **44** can be rotated at a different speed than the other drive wheels **44**. Thus the rotary slats **3** can be

operated at varying speeds, independent of the other rotary slats **3**. Each drive device **42** further comprises a drive motor (not shown) in driving engagement with the drive wheel **44** via a drive transfer mechanism (not shown). Each drive transfer mechanism comprises a drive shaft or other conventional power transmission components such as gears, belts, and pulleys. Accordingly, rotation of each drive motor causes the respective rotary slat **3** to rotate. An alternative drive assembly **41** comprising frustoconical drive wheels for rotating rotary slats **3** is further described in U.S. Patent No. 6,185,901, which is herein incorporated by reference and could be used to drive the drive wheels **44** acting on a groove (not shown) or the alignment guides **11** of the rotary slats **3**. Alternatively, the drive assembly **41** may comprise other components for engaging the rotary slats **3**. For example, the drive assembly **41** may comprise drive wheels **44** that engage other arrangements of flat or bevel gears and/or belts that are connected to the drive motors.

As each of the rotary slats **3** rotates, the pill apertures **7** move in a path defined by the outer peripheral edge portion **4** of the rotary slat **3**, passing through a first position **27** and a second position **28**, as shown in Figure 3A. Pills **23** contained in the common interior space **12** of the drum **2** are rotated and tumbled near the first position **27** of the pill apertures **7**. Pills **23** fall into, and become seated in, the pill apertures **7**. Once a pill **23** is seated in a pill aperture **7**, the shroud **15** prevents the pill **23** from falling through the pill aperture **7**. Instead, the pill **23** is held seated in the pill aperture **7** as the pill aperture **7** approaches the second position **28**. The second position **28** preferably occurs at or before a position where the tangential direction of the outer peripheral edge portion **4** of the rotary slat **3** at the pill aperture **7** is vertical. Because the shroud **15** extends to, but not beyond, the second position **28**, a pill **23** seated in a pill aperture **7** that reaches the second position **28** is no longer retained within the rotary slat **3** by the shroud **15**. Thus, the pill **23** falls out of the pill aperture **7** toward one of the chutes **25**, which directs the pill **23** into the container **22** that corresponds to the filling station **26**. A first air blower **20**, supported by a beam **31** extending longitudinally in the drum **2**, is configured to blow air toward the pill aperture **7** at the second position **28** in a direction toward the outside of the drum **2**. The first air blower **20** facilitates the ejection of the pills **23** from the pill apertures **7** in a direction toward the corresponding chute **35**. A second air blower **21** is configured to blow air toward the pill apertures **7** in a direction toward the inside of

the drum **2**. The second air blower **21** is located so that it blows air at the apertures **7** after the apertures have passed through the second position **28** and before they have reached the first position **27**. If a pill **23** becomes seated in one of the pill apertures **7** and is not ejected from the pill aperture **7** at the second position **28**, the second air blower **21** will exert a force upon the pill **23** so that the pill **23** falls back into the drum **2**. Thus, the pills **23** preferably enter the pill apertures **7** where the tangential direction of the rotary slats **3** is horizontal at the first position **27** and exit the pill apertures **7** where the tangential direction of the rotary slats **3** is vertical at the second position **28**.

The shroud **15** that is shown in the figures extends around approximately half the circumference of the outer peripheral edge portion **4**. The shroud **15** also defines a plurality of shroud cut-outs **16** that correspond to the positions of the alignment guides **11** and the cradle roller wheels **35** of the first and second cradle rollers **36, 38**. The alignment guides **11** of the rotary slats **3** extend through the shroud cut-outs **16** to contact the cradle roller wheels **35**. Alternatively, the cradle roller wheels **35** can extend through the shroud cut-outs **16** to contact the rotary slats **3**. The shroud cut-outs **16**, and the cradle roller wheels **25**, are located out of the path defined by the pill apertures **7** so that the shroud **15** retains the pills **23** as they pass between the first position **27** and the second position **28** and the pills **23** do not escape through the shroud cut-outs **16**. It will be understood that the size and position of the shroud **15** can be varied from that shown in the figures, as may be necessary for optimum efficiency of the packaging apparatus **1** depending on the shape, size, and surface characteristics of the pills **23**.

The inner surface **6** of each of the rotary slats **3** may define a variety of shapes or patterns to increase the efficiency of the packaging apparatus **1**. For example, a rotary slat **3** according to one embodiment is shown in Figure 4. A cross-sectional view of the rotary slat **3**, shown in Figure 4A, shows an inner contour **9** defined by the inner surface **6** of the rotary slat. The inner contour **9** of this embodiment, which comprises a plurality of ridges **17**, facilitates the lifting of pills **23** as the rotary slat **3** rotates. The inner contour **9** is especially useful when the packaging apparatus **1** is used to package pills **23** that have a smooth or slippery outer surface because the inner contour **9** increases the mixing of the pills **23** and, hence, the likelihood that the pills **23** will become seated in the pill apertures **7**. The inner contour **9** may also comprise other ridges, bumps, grooves, channels,

knurling, and the like. The inner contour **9** may vary around the circumference of the rotary slat **3**, such as the ridges **17** shown in Figure 4A, or the inner contour **9** may be uniform around the circumference of the rotary slat **3**. Also, the inner contour **9** may extend to a location near the pill apertures **7**, or the inner contour **9** may intersect the pill apertures **7** so that the pill apertures **7** are disposed in the inner contour **9**. For example, as shown in Figure 4B, the inner contour **9** slopes toward the pill apertures **7** to comprise a groove in the rotary slat **3** that extends at the same depth around the entire circumference of the inner surface **6** of the rotary slat **3**. The pill apertures **7** are disposed within the groove of the inner contour **9** and the slope of the inner contour **9** toward the pill apertures **7** facilitates the entry of pills **23** into the pill apertures **7**.

The exit of the pills **23** from the pill apertures **7** is facilitated by the shape of the pill apertures **7**. In a preferred embodiment, shown in Figure 4C, the pill apertures **7** are not perpendicular to the tangent of the outer peripheral edge portion **4** of the rotary slats **3**. Instead, each pill aperture **7** is slanted downward, toward the outside of the drum **2**, when the pill aperture **7** is positioned at the second position **28**. Thus, a pill **23** disposed in the pill aperture **7** will tend to fall toward the outside of the drum **2** when the pill aperture **7** reaches the second position **28**. The rotary slat **3** shown in Figure 4A may be used with or without the first air blower **20**.

In an alternate embodiment shown in Figure 5A, plows **34** urge the pills **23** from the pill apertures **7** at the second position **28**. The plows **34** extend from the beam **31** toward the rotary slats **3**. Each plow **34** extends into a channel **19** defined by the inner surface **6** of each rotary slat **3**, as shown in Figure 5B. Each plow **34** has a curved surface that contacts the pills **23** and pushes the pills **23** out of the pill apertures **7** and toward the chutes **25**. The plows **34** may be used in conjunction with the first air blower **20**, but preferably the plows **34** are used instead of the first air blower **20**. Similarly, an upper plow (not shown) may substitute for the second air blower **21**. Additionally, or alternatively, a vibratory actuator may be mounted on the beam **31** to cause the pills **23** to drop from the apertures **7**.

As shown in Figure 3A, the packaging apparatus **1** includes a delivery sensor **33** associated with each filling station **26**. The delivery sensor **33** is positioned near the top of the chute **25** and is configured to detect the passage of each pill **23** into the chute **25** or

container **22**. The delivery sensor **33** detects the passage of each pill **23** as the pill enters the chute **25** and drops into the corresponding container **22**. Alternatively, the delivery sensor **33** may be positioned above, below, or elsewhere within the chute **25**. In the embodiment shown in Figure 3A, the top of each chute **25** is tangential to the drum **2** at the second position **28** of the rotary slats **3**, and each chute **25** curves toward the containers **22**. Each delivery sensor **33** detects across the tangential top of the respective chute **25**. It is appreciated that other embodiments of the chutes **25** are possible including, for example, straight chutes with horizontal or angled tops. Additionally, the chute **25** may not be necessary if the top of the container **22** is positioned proximate to the second position **28** of the rotary slat **3**. If no chute **25** is used, the delivery sensor **33** may be located between the second position **28** and the top of the container **22**.

Each delivery sensor **33** detects the passage of pills **23** along a delivery path associated with one of the filling stations **26** and extending from the second position **28** of the corresponding rotary slat **3** to the corresponding container **22** that is being filled at that filling station **26**. As shown in Figure 3A, each delivery sensor **33** is communicatively connected with a controller **50**. Together, the delivery sensor **33** for each filling station **26** and the controller **50** calculate the number of pills **23** that have been delivered to the container **22** or the number of pills **23** that still must be delivered to the container **22**. For example, in one embodiment, the delivery sensor **33** sends a signal to the controller **50** each time the delivery sensor **33** detects the passage of a pill **23** along the delivery path of the corresponding filling station **26**. The controller **50** counts the signals from the delivery sensor **33** and calculates the difference between the number of pills **23** that are desired to be delivered to the container **22** and the number of pills **23** that have been delivered to that container **22**. Thus, the controller **50** can determine when each container **22** has received the correct number of pills **23**.

The controller **50** is also in communicative contact with the drive motors of the drive assembly **41**. Depending on whether the container **22** corresponding to a particular filling station **26** has received the desired number of pills **23**, the controller **50** controls the driving motors to start rotating, continue rotating, or stop rotating the rotary slats **3**. When the controller **50** determines that one of the containers **22** has received the desired number of pills **23**, the controller **50** stops the drive motor that corresponds to the filling

station **26** of the filled container **22**. The drive motors corresponding to the other filling stations **26** continue to rotate the rotary slats **3** until the desired number of pills **23** have been delivered to each of the containers **22**. When the desired number of pills **23** has been delivered to each of the containers **22**, all of the rotary slats **3** are stopped and the conveyor **24** transports the filled containers **22** away from the filling stations **26**. When the delivery sensor **33** is positioned at the top of the chute **25**, a small delay may be built into the controller logic after the last pill **23** has been counted but before the conveyor **24** has been advanced to allow time for the last pill **23** to fall through the chute **25**. Because the controller **50** independently controls the delivery of pills **23** to each container **22** and independently calculates the number of pills **23** delivered to each container **22**, it is not important that the containers **22** are filled at uniform rates. Each container **22** receives the proper number of pills **23** even if some of the pill apertures **7** fail to receive and deliver pills **23**. Further, each container **22** receives the proper number of pills **23** regardless of whether more of the pill apertures **7** of one rotary slat **3** receive and deliver pills **23** than the pill apertures **7** of the other rotary slats **3**.

A number of transportation devices that are known in the art can be used to transport the containers **22** to the filling stations **26**, the most common type being the conveyor **24** comprising at least one conveyor belt and at least one conveyor motor **34**. Preferably, the conveyor **24** supports the containers **22** and transports them in a direction parallel to the axis of rotation of the rotary slats **3**. A first stop gate **60** is positioned proximate to the conveyor **24** so that when a first stop gate actuator **61** extends the first stop gate **60**, the first stop gate **60** blocks the path of the containers **22** on the conveyor **24** at the filling stations **26** and holds the containers **22** in positions corresponding to the filling stations **26**. Similarly, a second stop gate **62** is extended by a second stop gate actuator **63** to block the path of the unfilled containers **22** before they have entered the filling stations **26**. The first and second stop gate actuators **61**, **63** are controlled by the controller **50**. In a normal mode of operation, the first stop gate **60** is extended and the second stop gate **62** is retracted so that unfilled containers **22** are transported by the conveyor **24** into positions corresponding to the filling stations **26**. When a number of unfilled containers **22** corresponding to the number of filling stations **26** has proceeded past the second stop gate **62**, the second stop gate **62** is extended, blocking other

containers **22** from proceeding to the filling stations **26**. The conveyor motors **34** may stop once the containers **22** are in position, or the conveyor **24** may continue to move, sliding beneath the containers **22** held at the filling stations **26** by the stop gates **60**, **62**. The controller **50** starts the drive assembly **41** to begin filling the containers **22**. The controller **50** may also control the speed of the drive motors of the drive assembly **41**, so that, for example, each rotary slat **3** can be slowed down before the corresponding container **22** is filled to prevent overfilling. Additionally, the controller **50** can alternately accelerate and decelerate the rotary slats **3**, individually or in unison, to cause a jerking or vibratory motion in the rotary slats and agitate the pills **23**. Such agitation of the pills **23** can be useful in encouraging the pills **23** to become seated in the pill apertures **7**. After the containers **22** at the filling stations **26** have been filled, the first stop gate **60** is retracted so that the containers are transported away from the filling stations **26** for further processing or packaging. The second stop gate **62** is again retracted and the first stop gate **60** is extended so that different, unfilled containers **22** are transported to the filling stations **26**.

Alternatively, a screw auger (not shown) can be used to transport the containers **22** and position the containers **22** at the filling stations **26**. The screw auger maintains the containers **22** at consecutively spaced intervals, and as the screw auger is rotated, each of the containers **22** is transported toward or away from the filling stations **26**. Thus, the rotational speed of the screw auger can be adjusted to speed, slow, stop, or reverse the direction of the containers **22**.

The controller **50** is also in communicative contact with the level sensor **32** and a reservoir gate switch (not shown) that controls a reservoir gate **31**. The level sensor **32** detects the quantity of pills **23** in the common interior space **12** and communicates a corresponding value or signal to the controller **50**. For example, the level sensor **32** can detect the quantity of pills **23** by detecting the level of pills **23** piled in the common interior space **12**. When the controller **50** detects that the level of pills **23** in the common interior space **12** is below the desired level, the controller **50** signals the reservoir gate switch to open the reservoir gate **31**. By opening and closing the reservoir gate **31**, which controls the passage of pills **23** from the reservoir **30** to the common interior space **12** of the drum **2**, the controller **50** maintains a desired number of pills **23** in the rotary slats **3**

of the drum **2**. The desired level of pills **23** may be adjusted to optimize the seating of pills **23** in the pill apertures **7** and to prevent wearing or breaking of the pills **23** caused by overfilling of the drum **2**. Also, while the embodiment of Figure 3 shows a single reservoir **30** on one side of the drum **2**, it is also understood that multiple reservoirs **30** may be used. For example, an additional reservoir **30** may be positioned at the opposite end of the packaging apparatus **1**, so that pills **23** are fed into the common interior space **12** of the drum **2** through both end plates **13a**, **13b**. In the case where pills **23** are fed into the common interior space **12** through both end plates **13a**, **13b**, the first end plate **13a** is modified to define an aperture similar to the pill feed aperture **14** of the second end plate **13b**.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.